Study of Municipal Water System for City of Sturgis, SD

Prepared for:

City of Sturgis Water Department
1040 Second Street, Suite 102
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Presented by:

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July 22, 2009

Presentation Outline

- Introduction
- Purpose and Scope
- Existing System
- Hydraulic Water System Model
- Ft. Meade Water System Situation
- Annexation Areas
- Regionalization of Ft. Meade and City of Sturgis Water Systems
- Water System Needs / Costs
- Summary

Purpose and Scope

- Assess Existing Water System Facilities
  - System component conditions
  - System capacity
    - Existing demands
    - Future demands
- Create Hydraulic Model for Existing and Future Water System
  - Piping, Storage, PRV's, Wells
- Analyze City Water System Expansion Scenarios
  - East Annexation Area Alternatives
  - Entire Annexation Boundary Provided by City
- Obtain Water System Representative Input

Existing Water System Layout

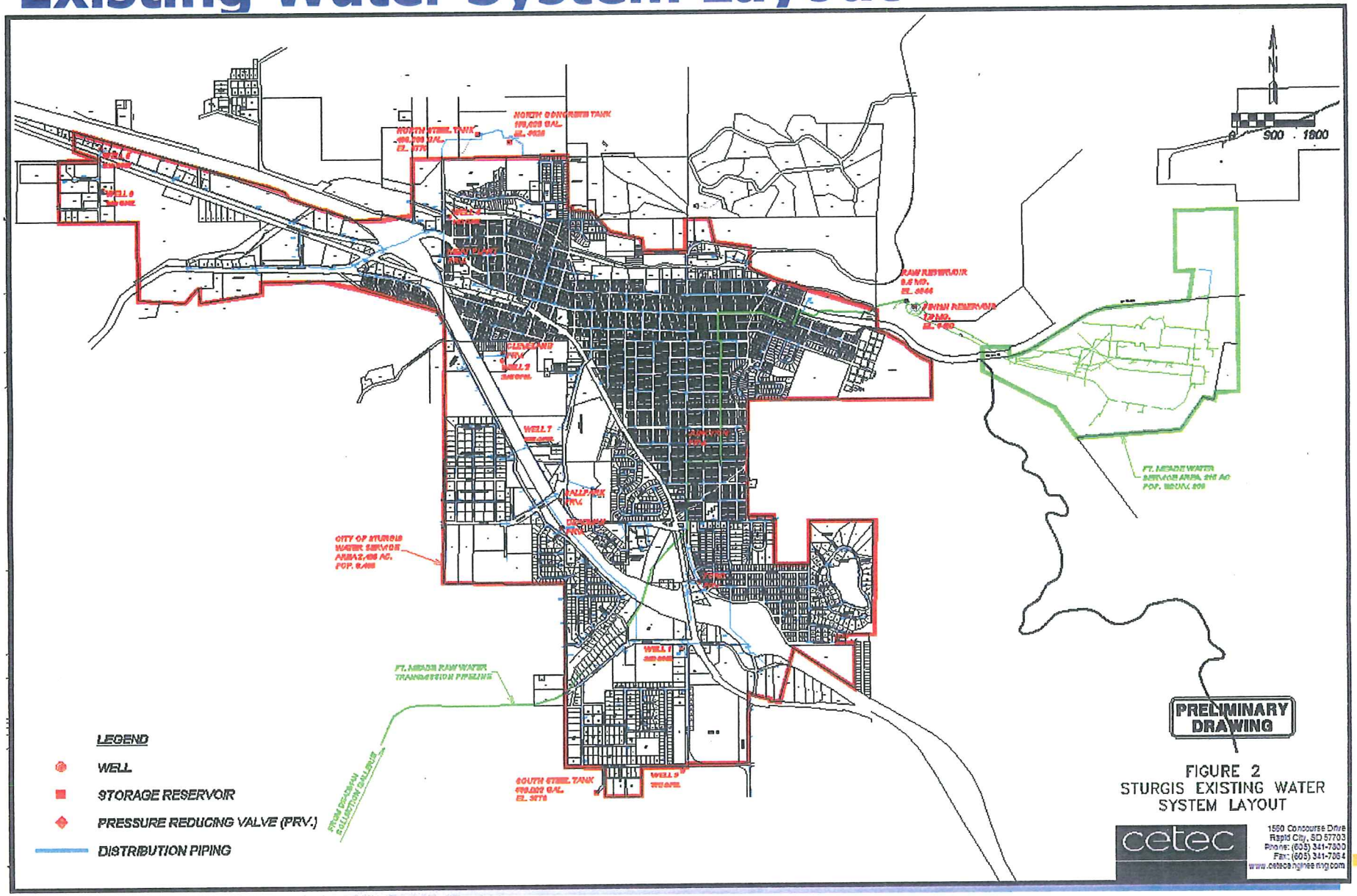

FIGURE 2
STURGIS EXISTING WATER SYSTEM LAYOUT

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Existing City Water System

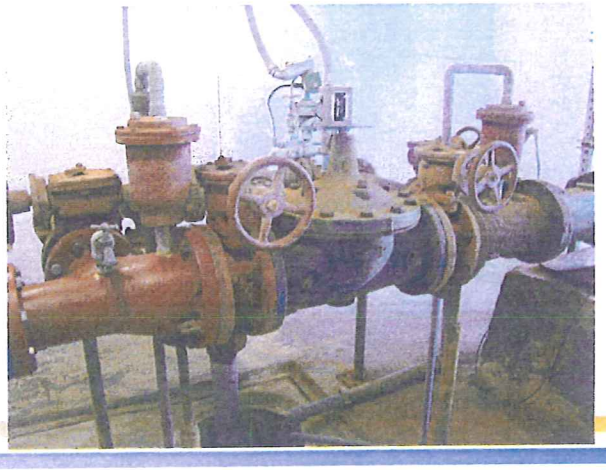
- SCADA System Control System
  - Existing Condition
    - 12 years old
    - Non-specific alarm system
  - Proposed Upgrades / Repairs / Etc.
    - Pressure gages with alarms at PRV's with New SCADA and RTU
    - Specific Alarm System
    - Offsite Internet access for operation and monitoring system

Existing City Water System Cont...

- **Well 1** (1948) – City Shop
  - Existing Condition
    - 350 gpm (summer operation only)
    - Poor Building Condition
    - Liner placed across portion of open hole – pump set in liner
    - Air problems – air bubbles
    - Last well within system operated, worst condition
  - Proposed Upgrades / Repairs / Etc.
    - Replace Well
    - Well casing does not justify the cost of upgrades

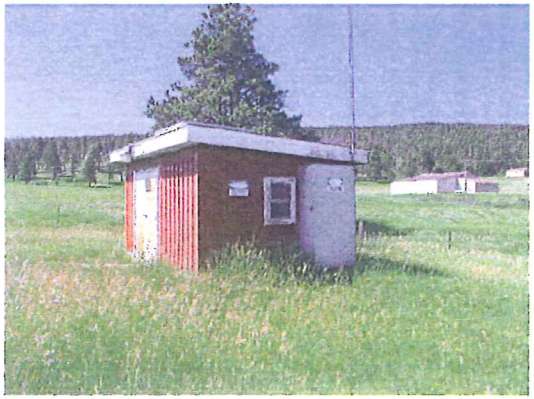
Existing City Water System Cont...

- **Well 2** (1950) – Cleveland Street
  - Existing Condition
    - 245 gpm (production during peak summer months)
    - Poor structural condition – roof in need of replacement
    - Higher production possible but poor water quality
    - Power line issue with well maintenance
  - Proposed Upgrades / Repairs / Etc.
    - Replace Well



Existing City Water System Cont...

- **Well 3** (1967) – Vanocker South
  - Existing Condition
    - 370 gpm
    - Very old structure in poor condition
    - Proposed City commercial development to south of well
    - Anticipated additional life of 5 to 20 years (casing dependent)
    - Casing condition unknown
    - Poor distribution system sizing
  - Proposed Upgrades / Repairs / Etc.
    - Automatic flush valve
    - Pitless adapter
    - Repair / replace entire structure
    - Good location for new well and well house



Existing City Water System Cont...

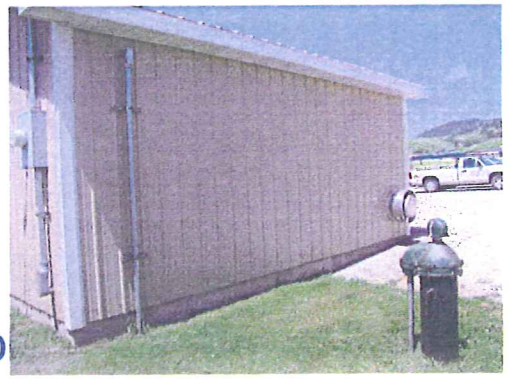
- **Well 4** (1982) – City Park
  - Existing Condition
    - 310-370 gpm (production during peak summer months)
    - Well has a sand separator
      - Very fine sand with partial bypass pump
      - Slowing well production does not reduce sand
    - Roof in need of replacement
    - Only well with wet floor alarm due to previous flooding

  - Proposed Upgrades / Repairs / Etc.
    - Automatic Flush Valve & Pitless Adapter
    - Upsize sand discharge lines
    - New roof / entire structure
    - New sand separators / automatic filters
    - Move Fluoride pump to separate Chemical Room

Existing City Water System Cont...

- **Well 5** (1987) – North Industrial Park
  - Existing Condition
    - 300-330 gpm
  - Proposed Upgrades / Repairs / Etc.
    - Automatic Flush Valve
    - Repair/Replace Shingle Roof
    - Move Fluoride pump to separate chemical room
    - Add distribution looping to reduce friction loss for Wells 5 & 6

- **Well 6** (2002) – South Industrial Park
  - Existing Condition
    - 300-330 gpm
  - Proposed Upgrades / Repairs / Etc.
    - Move Fluoride pump to separate chemical roo



Existing City Water System Cont...

- **Well 7** (2003) – Ball Park Road
  - Existing Condition
    - Typically 550-575 gpm
    - Primary Well
    - Operated year-round
    - Diesel Generator (Kohler Power Systems 350)
  - Proposed Upgrades / Repairs / Etc.
    - New Meter
    - Move Fluoride pump to separate Fluoride Chemical Room
  - New Booster Pump System
    - Increase production to 1,100 gpm
    - Add mechanical ventilation
    - New magnetic flow meter and pump control valve
    - New check valve and pressure relief valves

Existing City Water System Cont...

- **Well Summary**
  - Existing Conditions
    - Typical well casing well house infrastructure has 50-60 year life
    - Weston Engineering Repairs = $363,000 over 61 invoices (9 years)
    - All wells required in July and August to meet peak-day demand
    - Heavy reliance on Well 7

Well Condition Summary

Well No.	Typical Pumping Rate		Current Well Age	Water Quality Issues	Recommendations
1	350 gpm		61 years	Yes	Replace
2	245 gpm		59 years	Yes	Replace
3	370 gpm		42 years	No	Upgrade / Replace
4	310 gpm		27 years	Yes	Sand Upgrades /Replace Well House
5	300 gpm		22 years	No	Minor Upgrades
6	300 gpm		7 years	No	Minor Upgrades
7	625 gpm		6 years	No	Add booster pump and minor upgrades
	2,500 gpm	Average:	32 years		

Existing City Water System Cont...

• Well Summary Cont...

a. Total City Water Demands

	Existing City Demand	Existing w/ Existing Annex	Ultimate Future w/Annex
Average Day	1.0	1.1	1.87 MGD
Peak Month	2.2	2.5	4.2 MGD
Peak Day	2.75	3.42	6.17 MGD

b. Supply Situation 1: All existing wells running. Assumes existing wells are operational.

Well No.	(gpm) Pumping Rate	(gallons) 24 hr. Production	(gallons) 20 hr. Production	(gallons) 16 hr. Production	(gallons) 12 hr. Production
1	350	504,000	420,000	336,000	252,000
2	245	352,800	294,000	235,200	176,400
3	370	532,800	444,000	355,200	266,400
4	310	446,400	372,000	297,600	223,200
5	300	432,000	360,000	288,000	216,000
6	300	432,000	360,000	288,000	216,000
7	625	900,000	750,000	600,000	450,000
	2500	3,600,000	3,000,000	2,400,000	1,800,000

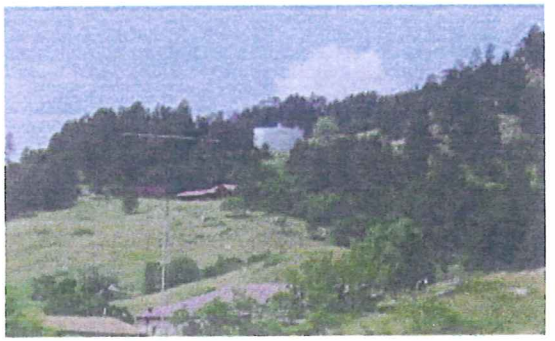
Existing City Water System Cont...

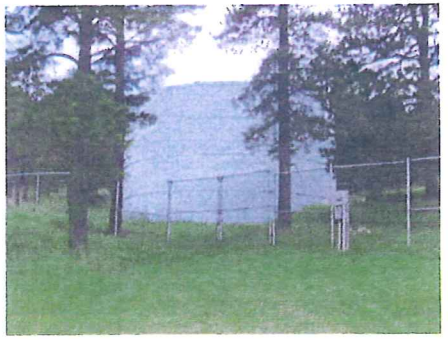
- **Pressure Reducing Valves (PRV)**
  - Existing Condition
    - No wet floor alarms/temperature alarms/air release valves
    - No above-ground regulators
    - No heat/light/ventilation/working drains
    - No ability to record or report pressure – no SCADA controls
    - Locations
      - Cleveland Street
      - Meat Plant
      - Ball Park
      - Deadman
      - Junction
      - Ford (10-yr old steel pit in good condition)

  - Proposed Upgrades / Repairs / Etc.
    - Construct above-grade structure over existing concrete structures
    - Improve access, safety, security, controls, monitoring

Existing City Water System Cont...

- **Storage (1.2 MG TOTAL)**
  - Existing Condition
    - North Steel Tank
      - 490,000 Gallons (HGL: 3770)
    - North Concrete Tank
      - 150,000 Gallons (HGL: 3620)
      - Serves area north of Bear Butte Creek in McKee Zone
    - South Steel Tank
      - 560,000 Gallons (HGL: 3770)
      - Altitude Valve
  - Proposed Upgrades / Repairs / Etc.
    - Repair North Reservoir fence and overflow AND possibly move valve pit above grade
    - Repair surrounding fence and overflow AND improve control valve pit for valve operation





Existing City Water System Cont...

- **Pine Acres Booster Pump Station**

  (Ponderosa & Greenwood)

  - Existing Condition
    - 2" line servicing 75-100 homes
    - Approx: 30-40 gpm
    - Pressure increased from 30-40 psi to 80-90 psi
    - Pit located at street corner
      - Poor condition
      - Inadequate working conditions
      - Safety and security issues
  - Proposed Upgrades / Repairs / Etc.
    - Replace booster with gravity flow reservoir for new pressure zone

Existing City Water System Cont...

EXISTING WATER SYSTEM UPGRADES SUMMARY

Well Capital Improvement Priorities		
1. Well 7 Booster:	$	200,000
2. Well 1:	$	1.277 million
3. Well 2	$	1.1 million
4. Well 3:	$	400,000
5. Well 4:	$	500,000
6. Well 5:	$	20,000
7. Well 6:	$	5,000

Minor Water System Capital Improvement Priorities		
1. Pressure Reducing Valve Stations - 6 locations:	$	75,000
	x	6 Each
Total PRV Upgrade:	$	450,000
2. North Steel Tank:	$	8,000
	$	32,000
Total Steel Tank:	$	40,000
3. North Concrete Tank:	$	8,000
	$	32,000
Total Concrete Tank:	$	40,000
4. South Tank:	$	32,000
5. Booster Pump Station:	$	75,000

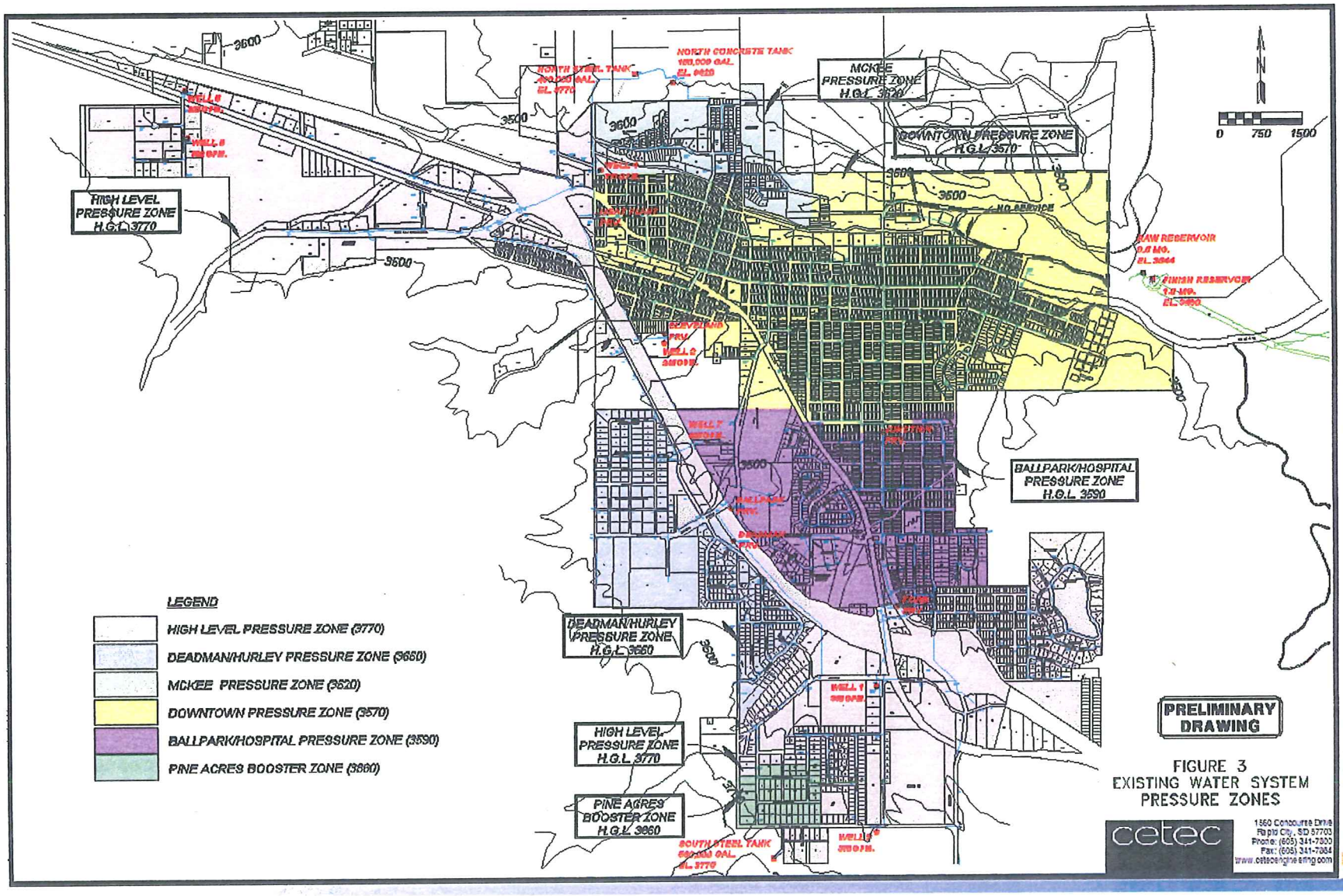
Existing City Water System Cont...

Distribution System Pressure Zones

Description	HGL*	Range of Elevations Served
Upper Pine Acres (Booster Pump)	3860	3690 to 3720
High Level (North and South Steel Tanks)	3770	3690** to 3500
Hurley / Deadman (West of I-90)	3660	3580 to 3500
Ballpark / Hospital (South of Deadwood St.)	3590	3500 to 3440
McKee (North Concrete Tank)	3620	3540 to 3440
Downtown	3570	3490 to 3350

*Hydraulic Grade Line (elevation of water in tank, booster gradeline or PRV setting).
**High-level zone serves some properties above 3690 at less than 35 psi.

Existing Water System Pressure Zones



Hydraulic Water System Model

Model Criteria

- Available Fire Flow Analysis

Minimum Fire Flow Requirements / Storage Requirements

Single Family Residential:	1,000 gpm for 2 hrs. =	120,000 gal.
Multi-Family / Commercial:	1,500 gpm for 2 hrs. =	180,000 gal.
Fort Meade NFF:	2,800 gpm for 2 hrs. =	336,000 gal.

- Water Demand
  - Average Daily Demand: the average of the total amount of water used each day during a one-year period.
  - Peak Daily Demand: the maximum total amount of water used during any 24-hour period in a three-year period.
  - Peak Hourly Demand: the maximum amount of water used in any single hour, of any day, in a 3-year period.

Hydraulic Water System Model

Model Criteria Cont...

- Controlling Factors
  - Forecasted Existing and Future Water Demands
  - Fire Flow
  - Supply
  - Pressure
  - Information Provided by City:
    - Annexation Area Limits
    - Future Land Use

Hydraulic Water System Model

- **Hydraulic Model Scenarios** – 21 Scenarios Reviewed
  - Scenario 1A
    - Existing System with Average Day Demand (all Wells ON)
  - Scenario 1B
    - Existing System with Average Day Demand (only Well 7 ON)
    - Confirmed Model with Existing System Conditions
  - Scenario 2
    - Existing System with Peak Day Demand
  - Scenarios 3, 4, 5 (East Annexation)
    - Existing and Future System with Peak Day Demand including the Rally for Northeast portion of Downtown and East Annexation Area

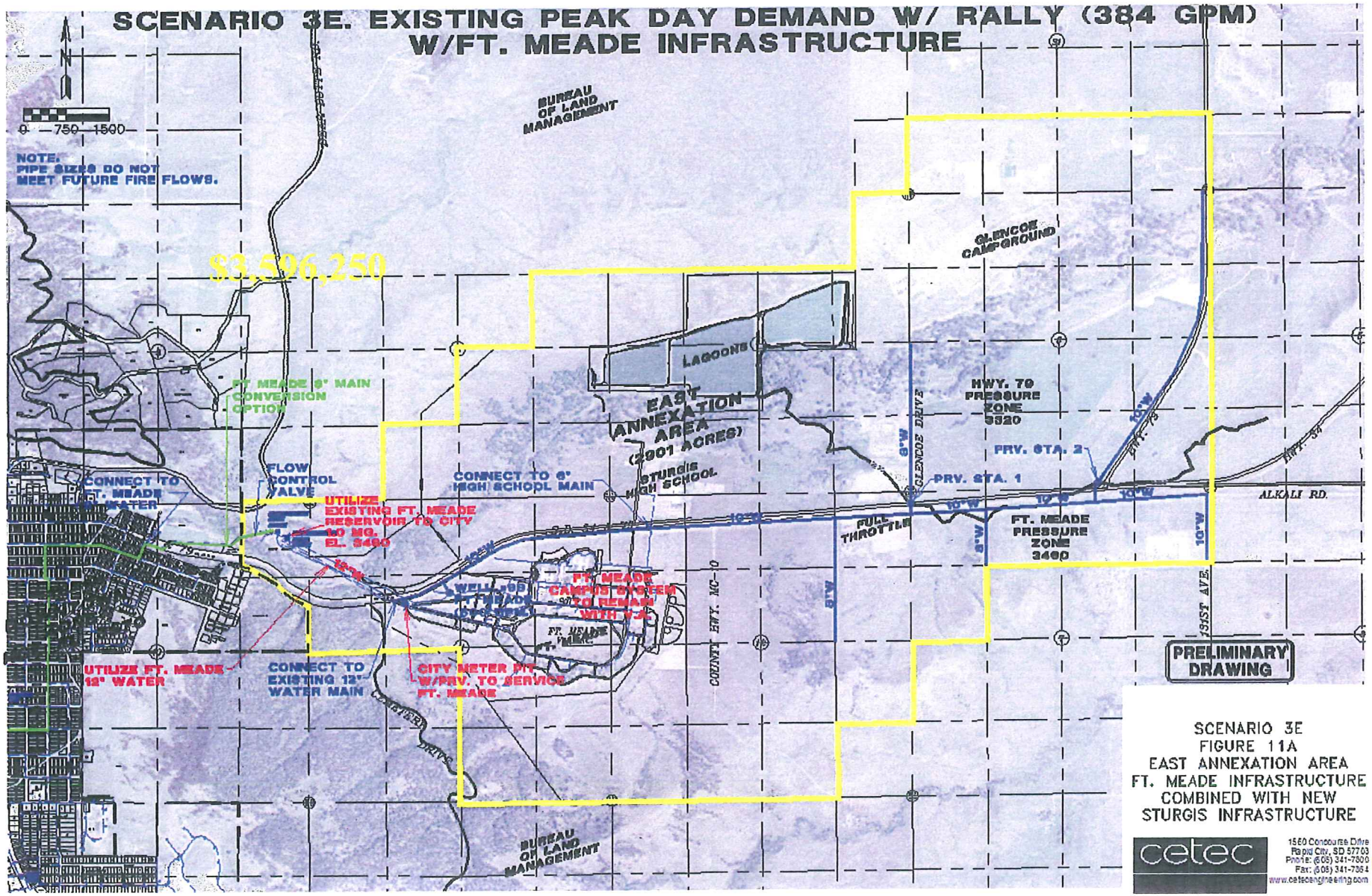
      – E = Scenario with Existing Peak Day Demand including Rally

      – F = Scenario with Future Peak Day Demand including Rally

Hydraulic Water System Model

- **Scenario 3 – East Annexation**
  - **Utilize Ft. Meade System and Provide Supply to Ft. Meade**
  - **Scenario 3E** **$3,596,250**
    - Existing Peak Day Demand including Rally – 384 gpm
    - Utilize Ft. Meade Infrastructure
      - 1 MG Tank, 8" Supply Main, 12" Distribution Main
  - **Scenario 3F** **$5,271,250**
    - Future Peak Day Demand including Rally – 838 gpm
  - **Results**
    - Good Fire Flows for both Scenarios
    - No Adverse Effects on Existing System for both Scenarios
    - 3E - 10" Water Main required east of Ft. Meade
    - 3F - Series of 10", 12" and 14" Water Main required east of Ft. Meade

Scenario 3E (Figure 11A)



SCENARIO 3E
FIGURE 11A
EAST ANNEXATION AREA
FT. MEADE INFRASTRUCTURE
COMBINED WITH NEW
STURGIS INFRASTRUCTURE

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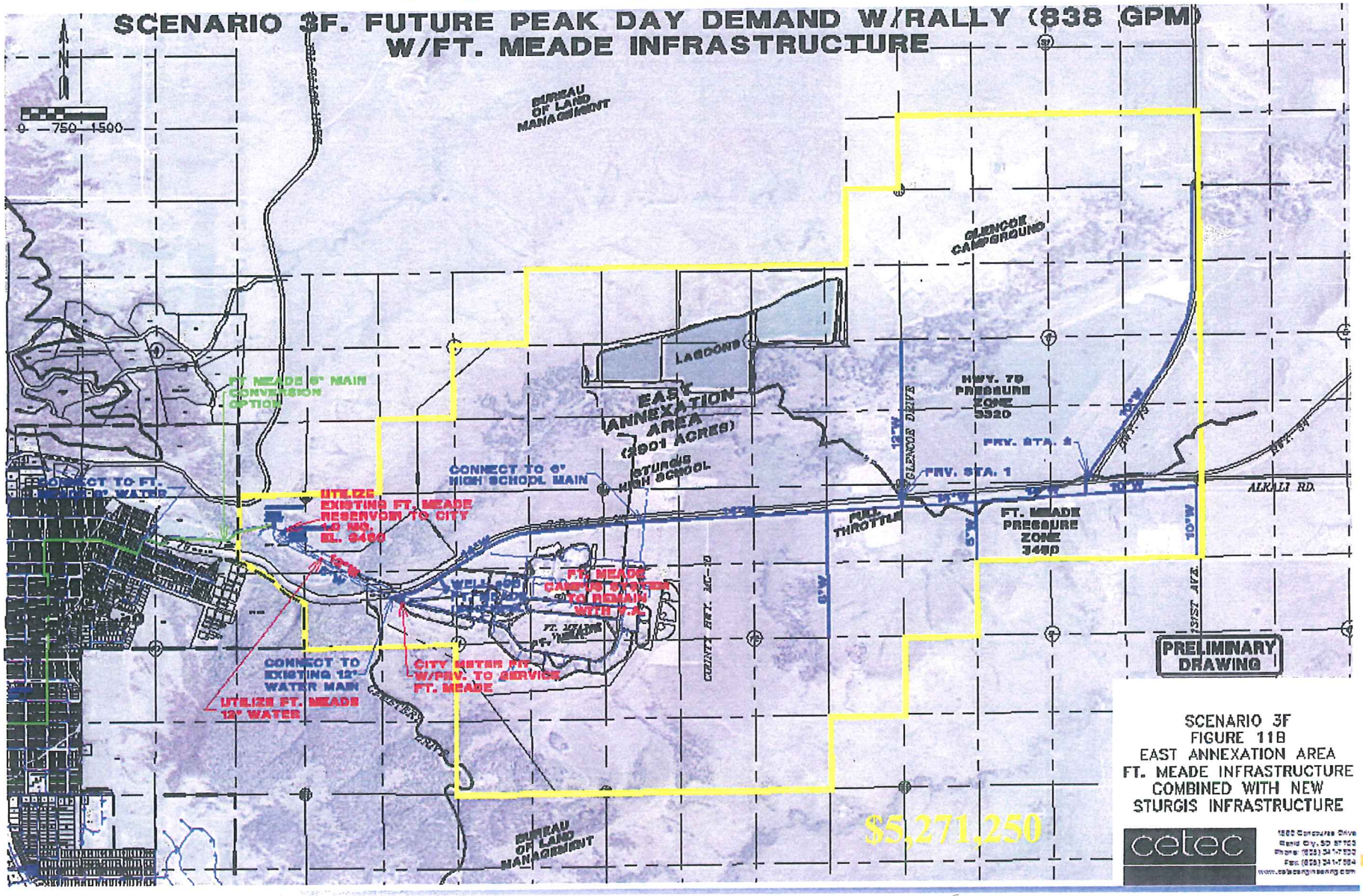
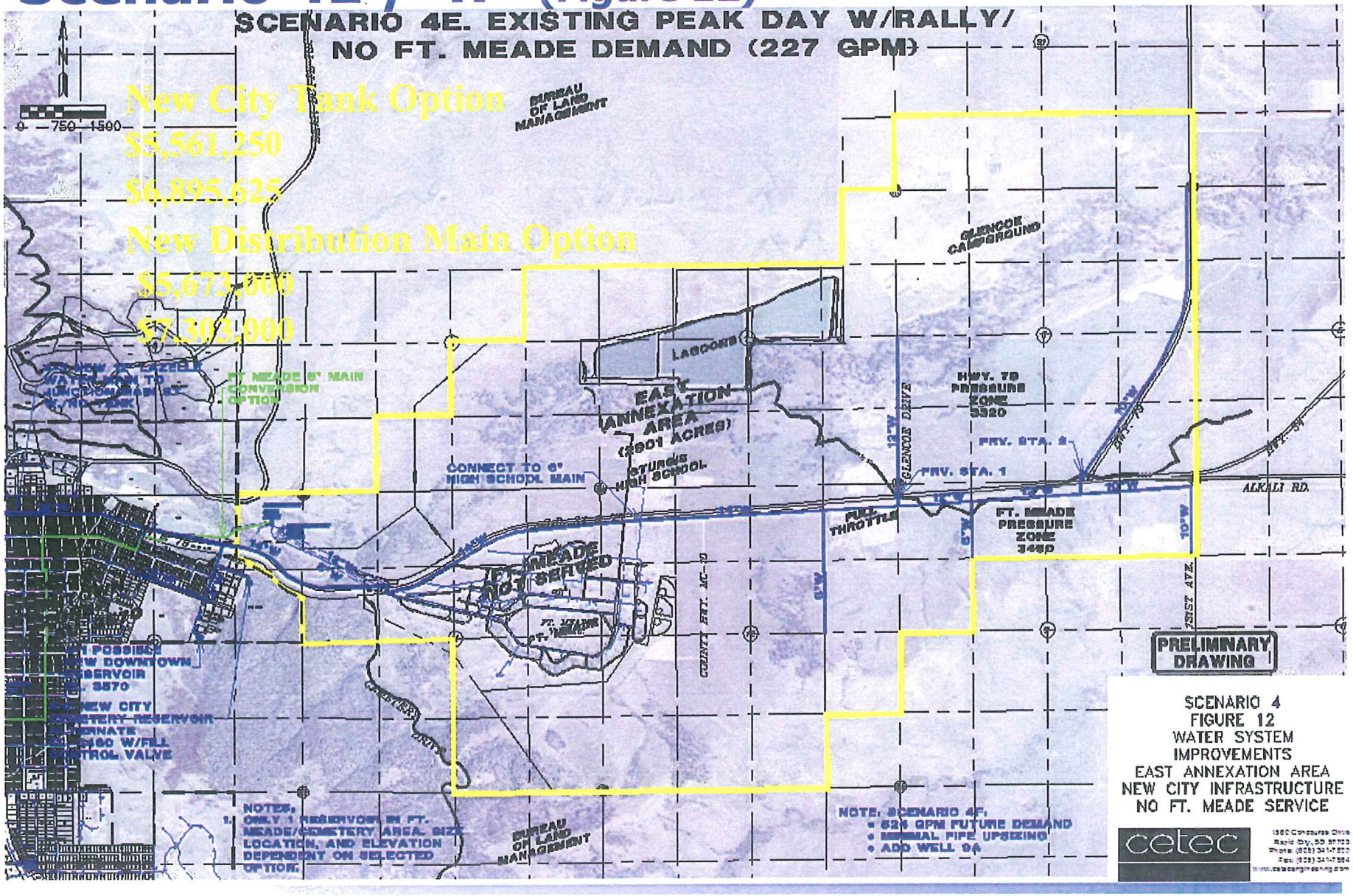
Scenario 3F (Figure 11B)



Hydraulic Water System Model

- **Scenario 4 – East Annexation**
  - **New City Infrastructure and DO NOT supply Ft. Meade**
  - **Scenario 4E**
    - Existing Peak Day Demand including Rally – 227 gpm
      - Utilize New City Tank (EL: 3570 or 3460) **$5,561,250**
      - Utilize New Large Distribution Main **$5,673,000**
  - **Scenario 4F -**
    - Future Peak Day Demand including Rally – 524 gpm
      - Utilize New City Tank (EL: 3570 or 3460) **$6,895,625**
      - Utilize New Large Distribution Main **$7,303,000**
  - **Results**
    - Good Fire Flows for all Scenarios
    - No Adverse Effects on City System with all Scenarios
    - Utilizing a New City Tank @ EL: 3570 provides best hydraulic conditions throughout City and to East Annexation Area
    - Without Tank, System cannot provide adequate fire flows without upsizing water main along Lazelle St and Junction Ave

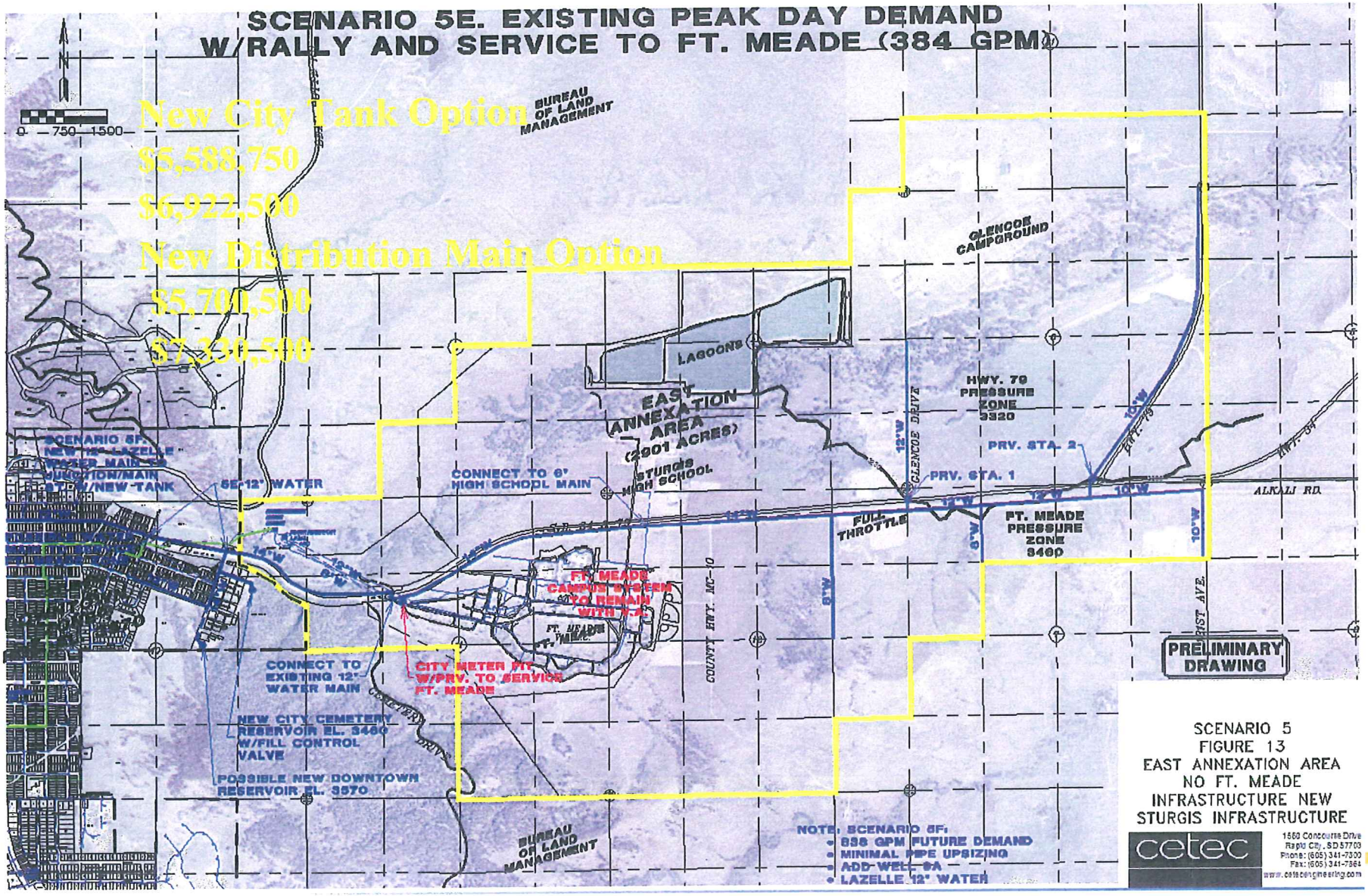
Scenario 4E / 4F (Figure 12)



Hydraulic Water System Model

- **Scenario 5 - East Annexation**
  - **New City Infrastructure and Supply to Ft. Meade**
  - **Scenario 5E**
    - Existing Peak Day Demand including Rally – 384 gpm
      - Utilize New City Tank (EL: 3570 or 3460) **$5,700,500**
        - » Utilize New City Distribution Main **$7,330,000**
    - **Scenario 5F**
    - Future Peak Day Demand including Rally – 838 gpm
      - Utilize New City Tank (EL: 3570 or 3460) **$5,588,750**
      - Utilize New City Distribution Main **$6,922,500**
  - **Results**
    - Good Fire Flows for all Scenarios
    - No Adverse Effects on City System with all Scenarios
    - Cannot provide adequate fire flows without:
      - New City Tank OR
      - Upsizing water main along Lazelle St and Junction Avenue to serve New City Large Distribution Main

Scenario 5E / 5F (Figure 13)



East Annexation Cost Summary

Estimate of Probable Costs
East Annexation Area Scenario Summary

Scenario		Total Cost Est. *
Fort Meade Pressure Zone		
Scenario 3E	(Utilize Ft. Meade Tank, Provide Service to Ft. Meade, 384 gpm)	$ 3,596,250
Scenario 3F	(Utilize Ft. Meade Tank, Provide Service to Ft. Meade, 838 gpm)	$ 5,271,250
Scenario 4-1E or 4-2E	(New City Tank, No Service to Ft. Meade, 227 gpm)	$ 5,561,250
Scenario 4-1F or 4-2F	(New City Tank, No Service to Ft. Meade, 524 gpm)	$ 6,895,625
Scenario 4-3E	(No Tank, No Service to Ft. Meade, 227 gpm)	$ 5,673,000
Scenario 4-3F	(No Tank, No Service to Ft. Meade, 524 gpm)	$ 7,303,000
Scenario 5E Option 1	(No City Tank, Provide Service to Ft. Meade, 384 gpm)	$ 5,700,500
Scenario 5E Option 2	(New City Tank, Provide Service to Ft. Meade, 384 gpm)	$ 5,588,750
Scenario 5F Option 1	(No City Tank, Provide Service to Ft. Meade, 838 gpm)	$ 7,330,500
Scenario 5F Option 2	(New City Tank, Provide Service to Ft. Meade, 838 gpm)	$ 6,922,500

*Total Cost includes Contingency/Engineering
*Total Cost is in 2010 Dollars
*Costs do not include any value for the Fort Meade Reservoir or Water Mains for Scenario 3E or 3F.

Ft. Meade Water System

- Sell/Lease or Transfer Existing Lines & Storage to City
- New Meter Pit
- VA will Retain Internal Campus Water System
  - System Value and Water Rates to be Negotiated

Hydraulic Water System Model

- **Scenarios 6 & 7 (South/North/West Annexation)**
  - Scenario 6 = Average Day Demand
  - Scenario 7 = Peak Day Demand

  - **South Annexation** **$4,581,500**
    - New SW High Level Zone with New Tank and New Well
    - New PRV for connection between SW High Level Zone and High Level Zone
    - Eliminate Pine Acres Booster Station

  - **West Annexation** **$6,726,250**
    - New Tank, Wells and Water Main

  - **North Annexation** **$2,794,000**
    - New Well and Water Main

  - **Central Annexation** **N/A**
    - No Additions Required

South Annexation Area (Figure 14)

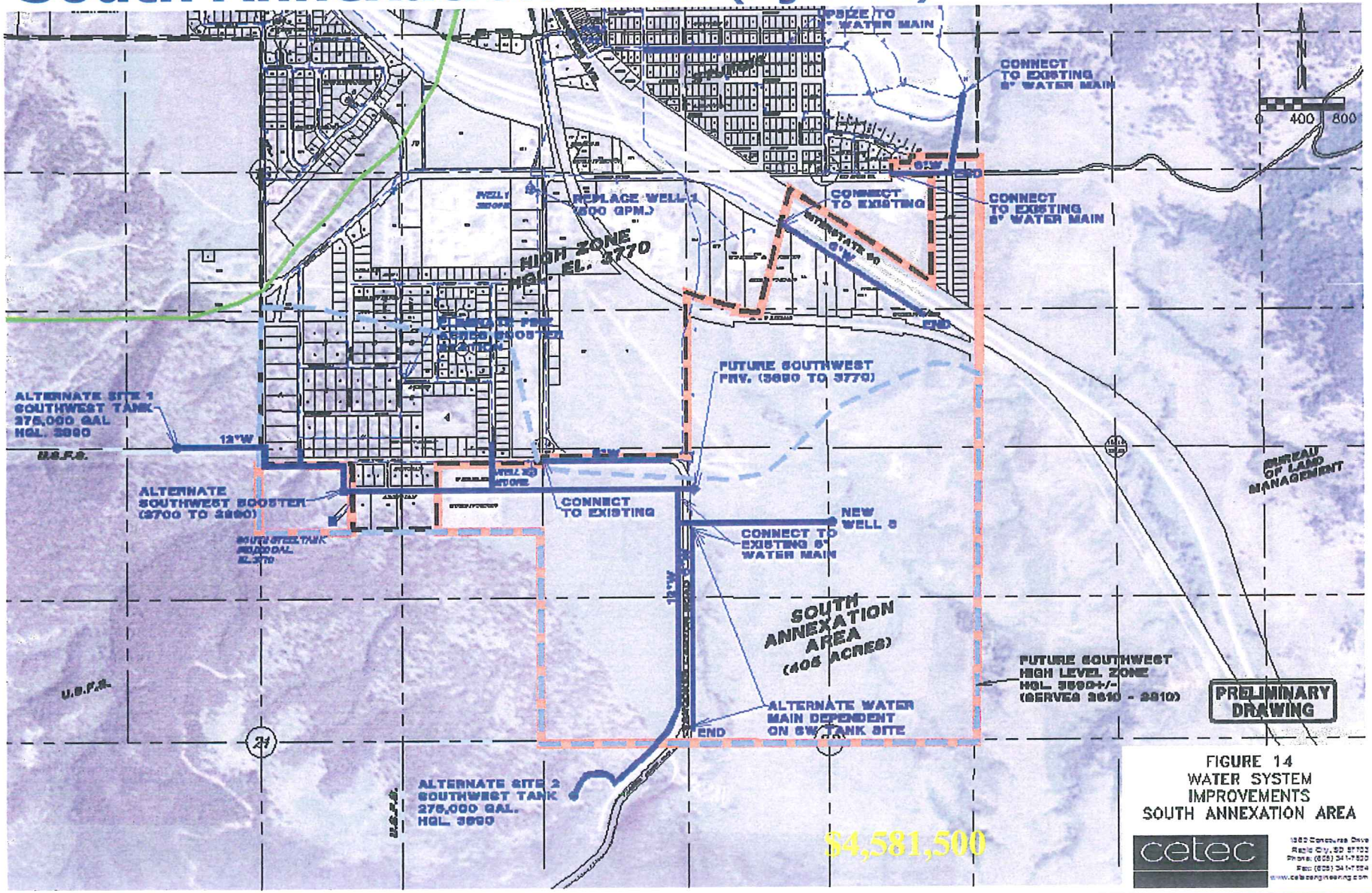


FIGURE 14
WATER SYSTEM
IMPROVEMENTS
SOUTH ANNEXATION AREA

$4,581,500

West Annexation Area (Figure 15)

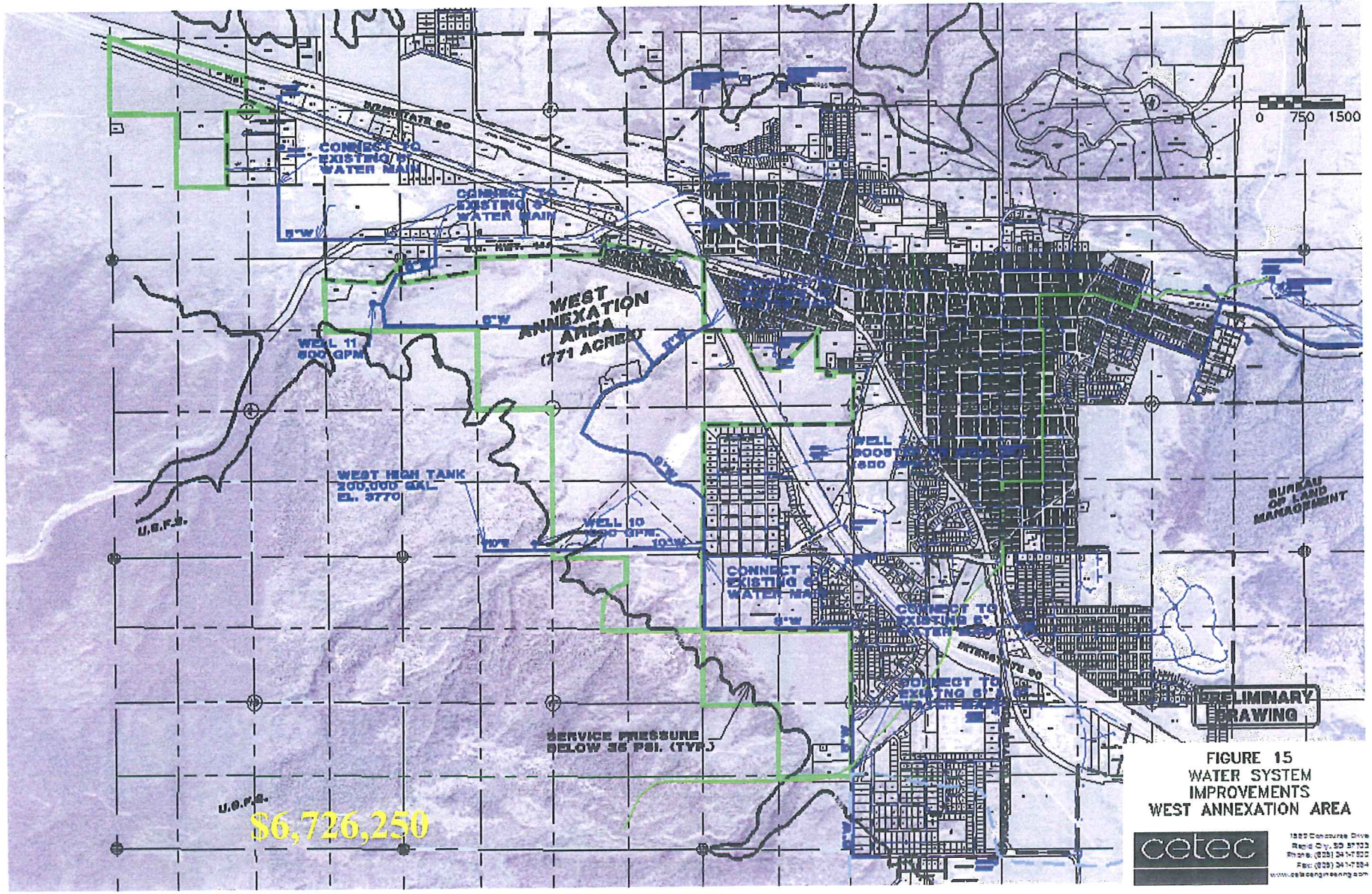


FIGURE 15
WATER SYSTEM
IMPROVEMENTS
WEST ANNEXATION AREA

North Annexation Area (Figure 16)

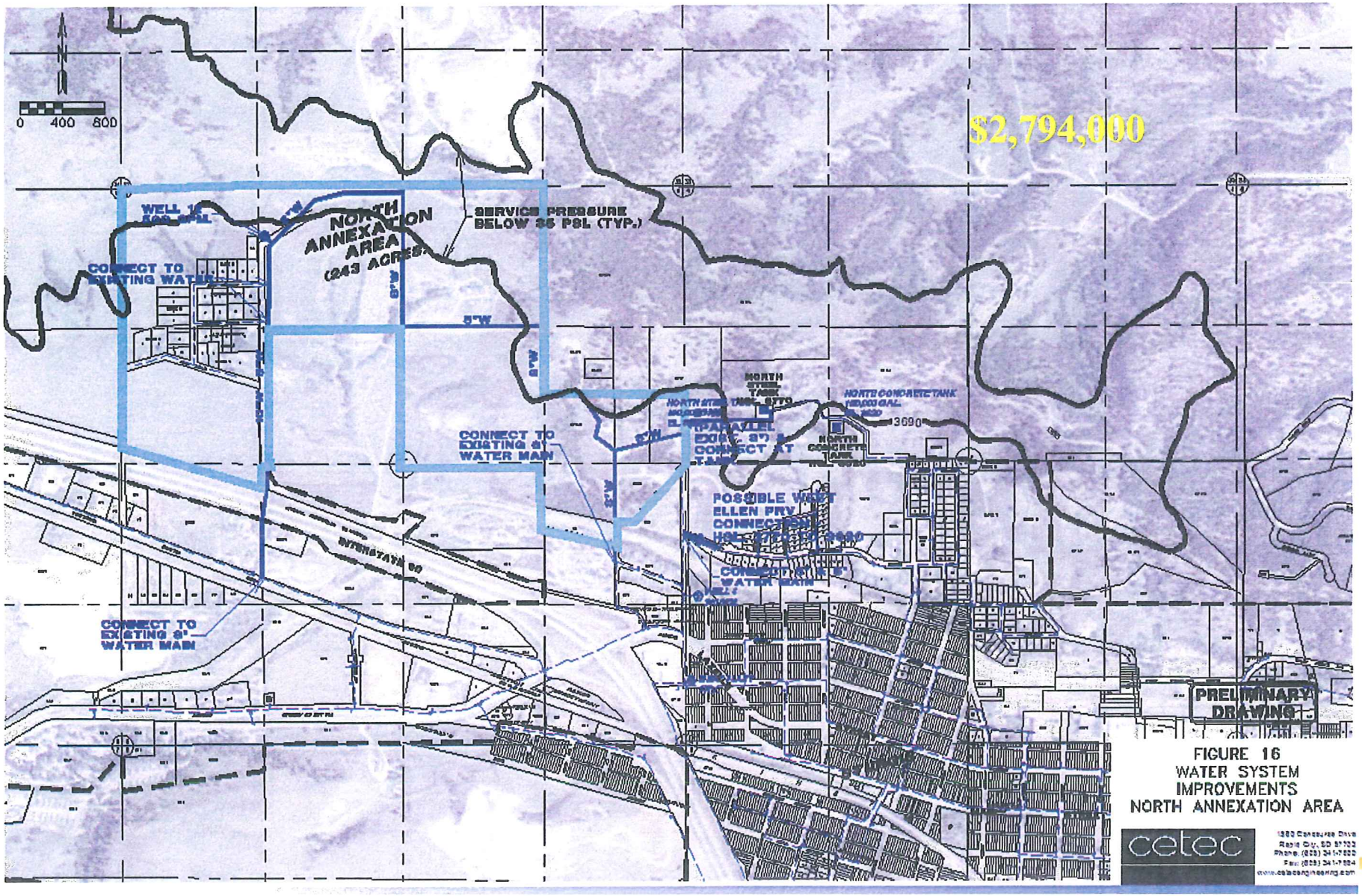


FIGURE 16
WATER SYSTEM
IMPROVEMENTS
NORTH ANNEXATION AREA

Hydraulic Water System Model

Existing City System Distribution Needs

- **East Existing City**
  - Upsize Water Main and add System Loop to improve Fire Flow
- **West Existing City**
  - Upsize Pipe within Murray Addition and add PRV to connect Deadman Zone with High Level Zone at an additional location to improve Fire Flow
- **North Existing City**
  - Add PRV between High Level Zone and McKee Zone to improve Fire Flow and Pressures
- **Central Existing City**
  - Add Loop between Well 7 and Ball Park Zone to improve Fire Flow
- **Entire City**
  - Replace 4" Cast Iron Pipe with 8" PVC Water Main for Fire Flow or with 6" Water Main to improve system standardization

	Pipe to Improve Fire Flow	Upsizing of 4" Pipe
High-Level Zone	0 LF	0 LF
Ball Park / Hospital Zone	3,500 LF	1,500 LF
Downtown Zone	7,200 LF	10,800 LF
Deadman / Hurley Zone	Included with West Annexation Discussion	
Pine Acres Booster Pressure Zone	0 LF	4,000 LF
McKee Pressure Zone	0 LF	0 LF

Existing System Distribution Needs Costs Summary

EXISTING SYSTEM DISTRIBUTION COSTS SUMMARY

1.	Lazelle Street (10th Street to Nellie Street and Junction Avenue (Main Street to Lazelle)	$ 1,672,250
2.	Main Street (5th Street to Nellie Street)	$ 1,244,125
3.	Ball Park / Hospital for Fire Flow	$ 729,750
4.	City 4" Main Replacement for Fire Flow	$ 2,542,000
5.	City 4" Main Upsizing	$ 3,898,600

*Costs are in 2010 Dollars and include Contingency and Engineering

Existing Sturgis Water System

Sturgis Water Demand Patterns (2003-2006)

Average Day Use (Annual)	981,557 gpd
Peak Month (7/06)	2,198,000 gpd
Peak Day *(07-19-06)	2,753,000 gpd
Average Day per Capita**	153 gpcd
Ratio of Peak Day to Average Day	2.80
Ratio of Peak Month to Average Day	2.24

* Historical peak day is based upon well production records.

** Per Capita Demand includes commercial and Rally uses.

Production Safety Factor (All Wells "On")

$$\frac{\text{Maximum Production}}{\text{Peak Day Use}} = \frac{3.6 \text{ MGD}}{2.753 \text{ MGD}} = 1.31$$

Production Safety Factor (One Average Well Off)

$$\frac{\text{Maximum Production (less 350 gpm)}}{\text{Peak Day Use}} = \frac{3.1 \text{ MGD}}{2.753 \text{ MGD}} = 1.12$$

Production Safety Factor (Well 7 Off)

$$\frac{\text{Maximum Production}}{\text{Peak Day Use}} = \frac{2.70 \text{ MGD}}{2.753 \text{ MGD}} = 0.98$$

Sturgis Water System Requirements

Minimum Fire Flow Requirements

Single Family Residential:	1,000 gpm for 2 hrs. =	120,000 gal.
Multi-Family / Commercial:	1,500 gpm for 2 hrs. =	180,000 gal.

Supply Storage Required

SSR = OS + FR
= .2(2,936,000 gal.) + 180,000 gal.
= 767,000 gallons

Existing Storage Volume Available

North Steel Tank	490,000 gal.
South Steel Tank	560,000 gal.
	1,050,000 gal.

Planning Criteria for Water System

Ratio Peak Day to Average Day Demand:	2.8
Production Capacity:	Meet Peak-Day Demand with a Minimum Safety Factor of 1.25.
Storage Volume:	20% of Peak-Day Demand Plus Fire Flow Requirement
Distribution System Sizing:	Minimum 35 psi @ Average Demand
	Minimum 20 psi @ Peak-Day Demand + Fire Flow
	Minimum 6" pipe size

*Fire Flow and Distribution Sizing is a Local System Decision

Annexation Area Demands

Total City Water Demands with Annexation

Demand Condition	Existing City (2006)	Annexation Area 2006	Annexation Area Future	Total City Water Demand 2006	Total City Water Demand Future
Average Day (No Rally)	0.98 mgd	0.11 mgd	0.89 mgd	1.09 mgd	1.87 mgd
Peak Day (with Rally)	2.75 mgd	0.68 mgd	3.42 mgd	3.43 mgd	6.17 mgd

Recommended Water Pressure Zones for Annexation Areas

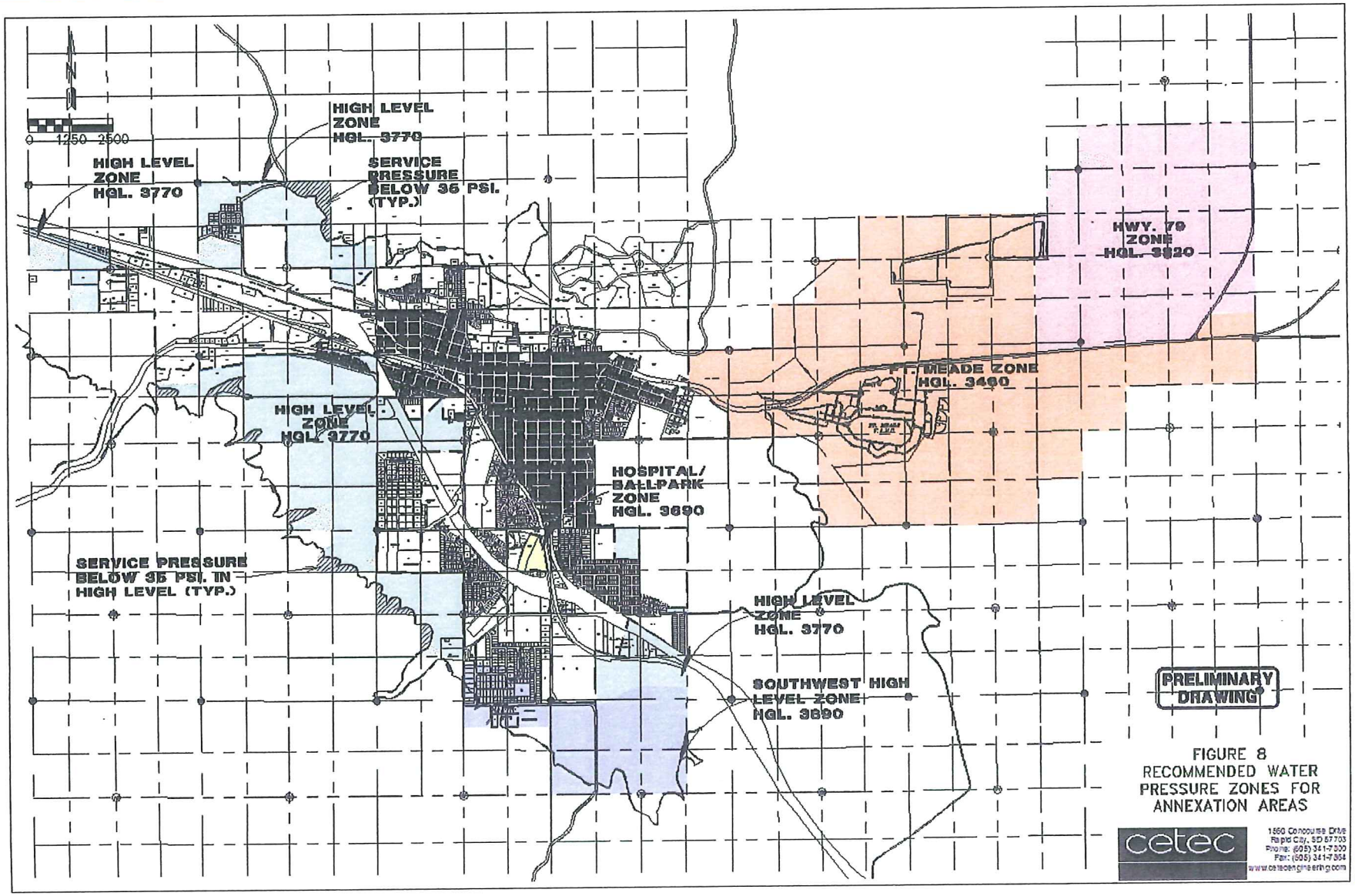


FIGURE 8
RECOMMENDED WATER PRESSURE ZONES FOR ANNEXATION AREAS

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Water System Production

Water Production Capacity Analysis

Water Production		Water Demand					
		With Annexation Area Existing Development			With Annexation Area Future Development		
Supply Condition	Production Capacity	Peak Day	Surplus Deficit	Safety Factor	Peak Day	Surplus Deficit	Safety Factor
All Wells	3.60 mgd	3.42	0.18	1.05	6.17	-2.57	0.58
One "Avg." Well off*	3.10 mgd	3.42	-0.32	0.91	6.17	-3.07	0.50
Largest Well off**	2.70 mgd	3.42	-0.72	0.79	6.17	-3.47	0.44

*Avg. Well 350 gpm, 0.5 mgd.

**Largest Well No. 7, 625 gpm, 0.9 mgd

Recommended Additional Water Supply Capacity

(With Annexation Areas - Existing Development) w/ 1.25 Safety Factor

Existing Supply	3.60 mgd		
Peak Day Demand	3.42 mgd		
Total Supply Needed	3.42 x 1.25	=	4.28 mgd
New Supply Needed	4.28 - 3.60	=	0.68 mgd (472 gpm)

Water System Needs

Recommended Additional Water Supply Capacity

(With Annexation Areas - Future Development) w/ 1.25 Safety Factor

Existing Supply	3.60	mgd		
Peak Day Demand	6.17	mgd		
Total Supply Needed	6.17	x 1.25	=	7.71 mgd
New Supply Needed	7.71	- 3.60	=	4.11 mgd (2,855 gpm)

Recommended New Wells and Sources

Well No.	Location	Pump Into This Zone	Design Pumping Rate
7B	Booster at Well 7	High Level	600 gpm
8	East of Well 3	High Level and SW High Level	500 gpm
9A or 9B	Fort Meade Vicinity / City Park	Fort Meade or Downtown	500 gpm
10	West Dolan Creek Rd. Vicinity	High Level	500 gpm
11	West Hwy. 14-A	High Level	500 gpm
12	Avalanche Road	High Level	500 gpm
		Total New Production	3,100 gpm
		Existing Production (Wells 1-7)	2,500 gpm
		Total Future Production	5,600 gpm (8 mgd)

Water System Storage

New Pressure Zones

Zone Name	HGL Elevation	Service Elevations
Southwest High Level	3890	3610 to 3810
Fort Meade	3460	3380 to 3240
Highway 79	3320	3240 to 3150

Storage Need in High-Level Zone with Existing Development in Annexation Areas

Existing Peak-Day Demand:	2,753,000 gpd
Peak-Day Existing Annexation Development:	683,000 gpd
Total Peak-Day with Annexation	3,436,000 gpd

Total Storage Need:

Operating Storage	+ Fire Storage	= Total Storage
0.2 x 3,436,000	+ 180,000	= 867,000 gal.

Existing Storage (North and South Steel Tanks):	1,050,000 gal.
Excess Storage Available:	187,000 gal.
Safety Factor	1.21

Future Water System Storage

Future Storage Need in High-Level Zone

Existing Peak-Day Demand:	2,753,000 gpd
Future Peak-Day from Annexation:	3,416,000 gpd
Total Future Peak-Day	6,169,000 gpd
Estimated Southwest High-Level Zone Peak-Day Demand (Demand removed from High-Level Zone)	750,000 gpd
Total Future Storage Need in High-Level Zone 6,169,00 - 750,000 =	5,419,000 gpd

Total Storage Need:

Operating Storage	+ Fire Storage =		Total Storage
0.2 x 5,419,000	+	180,000 =	1,263,800 gal.

Existing Storage (North and South Steel Tanks):	1,050,000 gal.
Added Storage Need:	213,800 gal.

Ft. Meade / Hwy 79 Zone Water Storage

Fort Meade Fire Storage Requirement

2,800 gpm fire flow for 2 hours duration = 336,000 gallons

Storage Need in Fort Meade / Highway 79 Zone

Existing Peak-Day Demand (Fort Meade)	255,000 gpd
Existing Peak-Day Demand (Annexation)	298,000 gpd
Total Peak-Day Demand with Annexation	553,000 gpd

Total Storage Need:

Operating Storage			+ Fire Storage	=	Total Storage
0.2	x	553,000	+ 336,000	=	447,000 gal.

Existing Storage Available (Ft. Meade Tank)	1,000,000 gal.
Excess Storage Available:	553,000 gal.
Safety Factor	2.23

Ft. Meade / Hwy 79 Zone Water Storage

Future Storage Need in Fort Meade / Highway 79 Zone

Future Peak-Day from Annexation:				1,207,000 gpd
Total Storage Need:				
Operating Storage		+ Fire Storage	=	Total Storage
0.2	x 1,207,000	+ 336,000	=	577,000 gal.
Existing Storage Available				1,000,000 gal.
Excess Storage Available				423,000 gal.
Safety Factor				1.93

- **Storage Evaluation without Ft. Meade Reservoirs**
  - New storage reservoir at EL: 3460 - 3570
  - Reservoir at elevation 3570 additional fire fighting capabilities and improved pressure.
    - Currently the downtown zone is only supplied by pressure reducing valves from the high zone.
  - City Park Well 9 and pump directly to the new Tank
  - Significant safety factor and operational reliability for the entire downtown area and east annexation area
  - New City storage reservoir is between 600,000 and 800,000 gallons

Future Water System Needs

Projected Future Water Demands for Entire City

	Peak-Day Water
Existing City	2.75 mgd
Annexation Areas	3.43 mgd
Total Demand	6.18 mgd

Water System Capacity

Component	Current Capacity	Needed Capacity	Excess (Deficit)
Well Supply	3.60 mgd	7.70 mgd	(4.10) mgd
Storage Capacity	1.05 mgd	1.41 mgd	(0.36) mgd

Summary / Questions